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ABSTRACT

An academic program instituting the PLATO system of computer-assisted instruction at the University of Illinois College of Veterinary Medicine is discussed. Procedures involved setting up an organization, establishing an administrative system, studying capabilities of the system, studying factors making a lesson suitable for programming, and preparing PLATO classroom facilities. More than 50 lessons were developed in all major subject areas of veterinary medicine. Included are expenditure data, information on the factors that influenced cost of lesson development, lengths of time required for lesson preparation, and factors of programmer efficiency. (MH)

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COST OF INITIAL DEVELOPMENT OF PLATO INSTRUCTION IN VETERINARY MEDICINE

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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COST OF INITIAL DEVELOPMENT OF PLATO INSTRUCTION IN VETERINARY MEDICINE*

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February, 1975

*Appreciation is extended to Mrs. Darlene Bennett, without whose help this report could not have been produced. She performed extensive calculations for the report as well as repeated typing of the report. Sheila Knisley typed the final draft.

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COST OF INTITIAL DEVELOPMENT OF PLATO INSTRUCTION IN VETERINARY MEDICINE

by

George M. Grimes, D.V.M., M.M.S.

From July 1970 through August 1974 the University of Illinois College of Veterinary Medicine (CVM) instituted the PLATO System in its academic program. Procedures involved setting up an organization, establishing an administrative system, studying capabilities of the system, studying factors making a lesson suitable for programming, training programmers, and preparing CVM PLATO classroom facilities. Approximately 317 instructional hours[a] were developed, and more than 8,000 student-contact hours[b] were spent using lessons. Some student-attitude and lesson-effectiveness evaluations were carried out. Finally, plans were made for future use of PLATO at CVM.

Lessons were developed in all major subject areas of veterinary medicine. An effort was made to select lessons from subjects that were particularly suitable for computer-based instruction. More than 50 lessons were developed, including simulation of a bacteriology laboratory,(1) interactive programs on veterinary diagnosis,(2) a problem-solving program in nutrition,(3) gaming

[a]An "instructional hour" is an estimate of the amount of instructional material which can be covered in one hour by an average student who studies the material thoroughly. Or, it is the amount of classroom or laboratory instruction time displaced by PLATO instruction. It is a figure that is subject to change as more data is obtained with increased usage of lessons.

[b]A "student-contact hour" is the amount of time in hours spent by one student using a PLATO lesson. It is recorded by the system as the student makes use of a lesson and is less subject to approximation than the "instructional hour."

programs in public health, and a heart-sounds identification program using the audio unit. An effort was made to select lessons from both basic and clinical science areas, from all four class levels, from both semesters, and from all months of the school year. The selection permits relatively even distribution of use of terminals throughout the year and more efficient use of lessons. An effort was also made to involve as many subject-matter specialists as possible in lesson development. During the four-year period, 24 instructors participated.(4)

The purpose of this paper is to report on expenditures, provide information on the factors which influence cost of lesson development at CVM, indicate lengths of time required for lesson preparation, and consider factors of programmer efficiency.

Summary of Expenditures

A total of $483,266 was expended during the four-year period. This sum includes all expenditures except computer usage and salaries of most instructors for and with whom lessons were developed. The computer usage was provided by the State of Illinois. Instructors' salaries were generally not included in the expenditures except those of released-time personnel or those of instructors paid by the PLATO Project. Several instructors spent substantial time in developing PLATO lessons; however, most instructors did not spend more time developing PLATO lessons than preparing their conventional instruction. The instructor's time is further diluted as the lesson is used over a period of years with minimum time required for revising. The procedures used for preparation of CVM PLATO lessons are designed to maximize use of the instructor's knowledge, while minimizing his time in lesson preparation and programming.(5)

The sources of funds for the CVM PLATO Project were as follows:

DHEW, NIH Special Projects Grant[a]	$251,733
DHEW, NIH Capitation Grants	158,565
Other Federal Funds	4,011
State Funds	68,957
TOTAL	$483,266

A summary of distribution of funds is as follow.

Lesson Programmer Salaries	$124,670	
Audiovisual (AV) Salaries (Photographers, Medical Illustrators, AV Maintenance, Etc.)	22,047	
Other Salaries (Coordinator, Administrative, Secretarial, Statistician, Nonproductive Personnel,[b] Etc.)	84,804	
TOTAL SALARIES		$231,521
AV Supplies (Films, Microfiche, Etc.)	$ 4,033	
General Supplies (Office, Books, Etc.)	4,498	
Travel (Primarily Consultants)	4,360	
Other (Communication Lines, Copy Work, Site Controller, Etc.)	18,089	
TOTAL SUPPLIES		30,980
Equipment (Terminals, Audio, AV, Etc.)		209,183
Classroom Renovation		11,582
GRAND TOTAL		$483,266

[a]Department of Health, Education, and Welfare, National Institutes of Health

[b]A few personnel did not stay with the project long enough to produce a lesson.

Table I lists detailed expenditures by lessons developed, hours of instructional material in each lesson, programmers for each lesson and proportional part of lesson, salaries of personnel as specified for each lesson, expenses as assigned to each lesson, the grand total cost of each lesson, estimated cost for each instructional hour, and estimated cost per student-contact hour if used by all students in the CVM over a five-year period.* It should be emphasized that figures shown in Table I are *not actual* costs for each lesson but are *proportional* to the instructional hours in each lesson over the four-year period. Individual lessons varied widely in time and cost to produce them. Table I does not include intitial costs of new equipment and classroom renovation in lesson development costs. The equipment is recoverable and the renovated classroom can be used for individualized instruction other than PLATO.

The total lesson development costs were $262,501, or an average of $828.00 per hour of instructional material. At the present level of 86 students per class, distributed over a five-year period, this cost represents $1.93 per student-contact hour. This calculation presumes that the lessons will be used at a maximum rate. These figures include the delivery of more than 8,000 student contact hours as well as the development costs. They represent the initial phases of PLATO lesson development for both the system as a whole and for the CVM.

Table I indicates that the cost of developing an hour of instruction varied from $512.00 to $1,763. The principal factors affecting the variation

*Total development cost ($262,501) ÷ (86 students per class × 5 years × 317 hours of instruction) = development costs per student-contact hour for five years.

in costs were level of development of the PLATO System, use of audiovisuals, programmer salary, length of time required to develop a lesson, and programmer efficiency.

Lessons listed in Table I are generally in chronological order in which the lessons were started. Lessons started in 1970 and some in 1971 were first programmed on PLATO III. These lessons were later reprogrammed on PLATO IV, the present stage of the system. As the system developed, not only did the hardware and the availability of terminals improve substantially, but the TUTOR* language was made more flexible and programming became easier. As programmers became more experienced, they were able to provide better instructions to novice programmers. The implementation of "common" storage tables further improved the manipulation of the system.

A total of $26,080 was spent for audiovisual personnel, including a part-time medical illustrator, and for audiovisual supplies. However, programs varied greatly in the amount of audiovisuals used with the greatest expenditures being for bacteriology, mycology, parasitology (arthropods), poultry diseases, and ophthalmology.

The 19 persons listed as lesson programmers included: one graduate veterinarian, one experienced computer programmer, one mathematics major, eleven veterinary students, and five from other fields (English, bio-chemistry, nuclear engineering, and business). The graduate veterinarian was coordinator of the project and directly participated in development of 26 hours of instruction. The computer programmer provided liaison with the systems programmers of the PLATO System, developed complex routines which could be

*TUTOR is the computer language used in the PLATO System.

TABLE I

ESTIMATED COST OF DEVELOPING CVM PLATO LESSONS

JULY, 1970 - AUGUST, 1974

LESSONS			SALARIES[a]				EXPENSES					GRAND TOTAL	DEV. COST PER HOUR	EST. COST OF DEV. PER STUD. HOUR FOR 5 YRS[g]
TITLE OR SUBJECT MATTER	INST. HRS.[b]	PROGRAMMERS AND HOURS[c]	SPECIFIED[d]	AUDIO-VISUAL[e]	OTHER[f]	TOTAL	AUDIO-VISUAL	SUPPLIES	TRAVEL	OTHER	TOTAL			
Started in 1970														
"PRINCIPLES OF CIRCULATION"	5	PROG. A 1 PROG. B 4	$ 256 2,468	$ 520	$ 1,338	$ 4,582	$ 95	$ 71	$ 56	$ 226	$ 448	$ 5,030	$ 1,006	$ 2.34
"ANATOMICAL TERMINOLOGY"	2	PROG. A 1 PROG. C 1	256 663	208	535	1,662	38	28	22	90 38	216	1,878	939	2.18
"IDENTIFICATION OF BACTERIOLOGICAL UNKNOWNS" & "LABORATORY CHARACTERISTICS OF INDIVIDUAL BACTERIA"	36	PROG. D 24 PROG. E 1 PROG. B 5 PROG. C 6	7,151 3,994 3,085 3,979	3,743	9,629	31,581	685	511	401	1,626 203	3,426	35,007	972	2.26
"IDENTIFICATION OF ARTHROPODS IMPORTANT IN VETERINARY MEDICINE"	7	PROG. F 5 PROG. G 2 PROG. H	1,618 529 620	728	1,872	5,367	133	99	78	316	626	5,993	856	1.99
"ESSENTIALS OF ENDOCRINOLOGY"	6	PROG. I 5 PROG. F 1 PROG. J	871 324 1,601		1,606	4,402		85	67	271 20	443	4,845	808	1.88
Started in 1971														
"VETERINARY DIAGNOSTIC PROGRAM"	25	PROG. W 15 PROG. K 5 PROG. L 1 PROG. C 4	3,822 3,561 674 2,652	2,600	6,688	19,997	476	355	279	1,129 10	2,249	22,246	890	2.07
"CANINE CARDIAC CONDITION"	5	PROG. I 5	871	520	1,338	2,729	95	71	56	226	448	3,177	635	1.48
"VETERINARY CYTOLOGY"	5	PROG. G 3 PROG. M 1 PROG. N 1	794 324 65	520	1,338	3,041	95	71	56	226	448	3,489	698	1.62
"HISTOLOGY SUPERQUIZ"	2	PROG. C 2 PROG. O	529 571	208	535	1,843	38	28	22	90	178	2,021	1,011	2.35
"ANTEMORTEM AND POSTMORTEM PROCEDURES"	9	PROG. A 4 PROG. Ph (9) PROG. C 5	1,024 324 3,315	936	2,407	8,006	171	128	100	406 708	1,513	9,519	1,058	2.46
"HISTOLOGY OF THE SKIN"	4	PROG. M 4 PROG. O	1,294 ,143	416	1,070	3,923	76	57	45	181	359	4,282	1,071	2.49
"SIMULATED ANTEMORTEM AND POSTMORTEM INSPECTION"	6	PROG. A 2 PROG. Ph (6) PROG. C 4	512 216 2,652	624	1,606	5,610	114	85	67	271 472	1,009	6,619	1,103	2.57
"FORMULATION OF A RADIOGRAPHIC TECHNIQUE CHART"	3	PROG. B 3	1,851	312	802	2,965	57	43	33	135	268	3,233	1,078	2.51
Started in 1972														
"IDENTIFICATION OF NORMAL AND ABNORMAL HEART SOUNDS"	4	PROG. Q 1 PROG. I : PROG. G 1 PROG. R 1	1,426 174 265 981	416	1,070	4,332	76	57	45	181 4	363	4,695	1,174	2.73

ESTIMATED COST OF DEVELOPING CVM PLATO LESSONS (CONTINUED)

LESSONS			SALARIES[a]				EXPENSES					GRAND TOTAL	DEV. COST PER HOUR	EST. COST OF DEV. PER STUD. HOUR FOR 5 YRS[g]
TITLE OR SUBJECT MATTER	INST. HRS.[b]	PROGRAMMERS AND HOURS[c]	SPECIFIED[d]	AUDIO-VISUAL[e]	OTHER[f]	TOTAL	AUDIO-VISUAL	SUPPLIES	TRAVEL	OTHER	TOTAL			
"THE BIOELECTRIC PROPERTIES OF CELL MEMBRANES"	2	PROG. Q 2	$ 2,851		$ 535	$3,386		$ 28	$ 22	$ 90	$ 140	$ 3,526	$1,763	$ 4.10
"PUPILLARY LIGHT REFLEXES"	2	PROG. G 2	529	$ 208	535	1,272	$ 38	28	22	90	178	1,450	725	1.69
"HEART VALVE LOCATIONS"	1	PROG. G 1	265	104	268	637	19	14	11	45	89	726	726	1.69
"IDENT. OF HORMONE UNKNOWNS"	10	PROG. I 10	1,741		2,676	4,417		142	111	452	705	5,122	512	1.19
"VETERINARY MYCOLOGY PROGRAM"	10	PROG. D 2 PROG. T 5 PROG. S 2 PROG. C 1	596 2,964 561 663	1,040	2,676	8,500	190	142	111	452	895	9,395	940	2.19
"CANINE NEUROLOGICAL DIAGNOSIS"	15	PROG. I 15	2,612	1,560	4,012	8,184	286	213	167	677	1,343	9,527	635	1.48
"POULTRY DISEASES"	20	PROG. R 10 PROG. D 10	9,810 2,980	2,080	5,350	20,220	381	284	223	903	1,791	22,011	1,101	2.56
"QUIZ ON INTERNAL PARASITES OF DOMESTIC ANIMALS"	2	PROG. I 2	348	208	535	1,091	38	28	22	90	178	1,269	635	1.48
"VETERINARY OPHTHALMOLOGY"	17	PROG. G 17 PROG. U	4,498 2,568	1,768	4,548	13,382	324	241	189 832	768 750	3,104	16,486	970	2.26
"CLINICAL PATHOLOGY EXERCISES ON ANEMIA"	2	PROG. I 2	348		535	883		28	22	90	140	1,023	512	1.19
"IDENTIFICATION OF VIRAL UNKNOWNS"	11	PROG. T 6 PROG. S 5	3,557 1,402	1,144	2,942	9,045	209	156	123	497	985	10,030	912	2.12
Started in 1973 "VETERINARY PUBLIC HEALTH ASPECTS OF MILK"	3	PROG. A 1 PROG. Ph (3) PROG. C 2	256 108 1,326		802	2,492		43	33	135 236	447	2,939	980	2.28
"DIAGNOSIS OF CANINE HIP DISPLASIA"	2	PROG. B 1 PROG. I 1	617 174	208	535	1,534	38	28	22	90	178	1,712	856	1.99
"FINANCIAL ANALYSIS OF A VETERINARY PRACTICE"	9	PROG. F 4 PROG. D 5 PROG. V	1,295 1,490 176		2,407	5,368		128	100	406	634	6,002	667	1.55
"VETMED CALCULATOR"	3	PROG. G 3	794		802	1,596		43	33	135	211	1,807	602	1.40
"COMMON CANINE TUMORS"	4	PROG. G 4	1,058		1,070	2,128		57	45	181	283	2,411	603	1.48
"EKG INTERPRETATION"	3	PROG. I 3	522	312	802	1,636	57	43	33	135	268	1,904	635	1.48
"PASTEURIZATION OF MILK AND DAIRY PRODUCTS"	2	PROG. A 1 PROG. Ph (2) PROG. C 1	256 72 663	208	535	1,734	38	28	22	90 157	335	2,069	1,035	2.41
"FOOD-BORNE DISEASE INVESTIGATION"	2	PROG. A 2 PROG. Ph (2)	512 72		535	1,119		28	22	90 157	297	1,416	708	1.65

ESTIMATED COST OF DEVELOPING CVM PLATO LESSONS (CONTINUED)

LESSONS			SALARIES[a]				EXPENSES					GRAND TOTAL	DEV. COST PER HOUR	EST. COST OF DEV. PER STUD. HOUR FOR 5 YRS [g]
TITLE OR SUBJECT MATTER	INST. HRS.[b]	PROGRAMMERS AND HOURS[c]	SPECIFIED[d]	AUDIO-VISUAL[e]	OTHER[f]	TOTAL	AUDIO-VISUAL	SUPPLIES	TRAVEL	OTHER	TOTAL			
"EXOTIC DISEASES"	5	PROG. G 5	$ 1,323	$ 520	$ 1,338	$ 3,181	$ 95	$ 71	$ 56	$ 226	$ 448	$ 3,629	$ 726	$ 1.69
"VETERINARY TERMINOLOGY PROGRAM"	6	PROG. A 4 PROG. C 2	1,024 1,326		1,606	3,956		85	67	271	423	4,379	730	1.70
"NUTRITION PROBLEMS"	10	PROG. M 10	3,236		2,676	5,912		142	111	452	705	6,617	662	1.54
"ELECTROCARDIOGRAPHY"	1	PROG. T 1	593		268	861		14	11	45	70	931	931	2.17
"CASES IN CLINICAL PATH"	9	PROG. I 9	1,567		2,407	3,974		128	100	406	634	4,608	512	1.19
"THE CARDIAC CYCLE"	2	PROG. X 2	354		535	889		28	22	90	140	1,029	515	1.20
"PROTOZOA OF IMPORTANCE IN VETERINARY MEDICINE"	4	PROG. X 4	707	416	1,070	2,193	76	57	45	181	359	2,552	638	1.48
Started in 1974 "SELF-ASSESSMENT STUDY QUESTIONS"	5	PROG. F 1 PROG. A 4 PROG. Ph (10)	324 1,024 360		1,338	3,046		71	56	226 393	746	3,792	758	1.76
"WHITE BLOOD CELL COUNTS AND DIFFEPENTIALS"	4	PROG. I 4	696		1,070	1,766		57	45	181	283	2,049	512	1.19
"TRANSMISSION OF ZOONOSES"	2	PROG. A 2 PROG. Ph (2)	512 72		535	1,119		28	22	90 157	297	1,416	708	1.65
"VETERINARY PUBLIC HEALTH"	6	PROG. A 6 PROG. Ph (6)	1,536 216		1,606	3,358		85	67	271 472	895	4,253	709	1.65
"STUDENT SELF-ASSESSMENT PROGRAM - HISTOLOGY"	3	PROG. A 3	768		802	1,570		43	33	135	211	1,781	594	1.38
"NEUROANATOMY OF SPINAL REFLEX LOOPS"	1	PROG. X 1	177		268	445		14	11	45	70	515	515	1.20
"INNERVATIONS OF THE THORACIC AND PELVIC LIMBS"	10	PROG. X 10	1,769		2,676	4,445		142	111	452	705	5,150	515	1.20
"FUNDAMENTALS OF URINE FORMATION"	2	PROG. S 2	561		535	1,096		28	22	90	140	1,236	618	1.44
"PEARSON SQUARE"	3	PROG. N 3	971		802	1,773		43	33	135	211	1,984	661	1.54
"SELF-ASSESSMENT PROGRAMS — MICROBIOLOGY"	5	PROG. F 2 PROG. A 3	647 768	520	1,338	3,273	95	71	56	226	448	3,721	744	1.73
TOTALS	317	317	$ 124,670	$ 22,047	$ 84,804	$ 231,521	$ 4,033	$ 4,498	$ 4,360	$ 18,089*	$ 30,980	$ 262,501		
											AVERAGE COSTS		$ 828	$ 1.93

* INCLUDES $5,137 FOR SITE CONTROLLER PORTS

SUMMARY

Total Salaries and Expenses for Lesson Development	$ 262,501
Total Cost of Equipment (In Inventory)	$ 209,183
Physical Plant Services – Renovation	$ 11,582
TOTAL EXPENDITURES FROM GRANTS AND NON-RECURRING FUNDS	$ 483,266

FOOTNOTES

a — Salaries – Excludes salaries of subject-matter specialists.

b — Instructional Hours – Estimated number of instructional hours available for student use.

c — Programmers and Hours – Programmers associated with lessons and estimated part of total lesson hours for which lesson programmer was responsible.

d — Specified Salaries – Calculation of salary assignable to specific lessons. (Total lesson programmer's salary ÷ total number of lesson hours produced by the programmer × number of lesson hours assignable to the programmers.)

e — Audiovisual Salaries – Salaries paid to audiovisual and medical illustrations personnel divided among lessons that use audiovisuals. (Total audiovisual salaries ÷ total hours of lessons × hours per lesson.)

f — Other Salaries – Salaries paid to secretaries, non-productive programmers, etc. (Total other salaries ÷ total hours of lessons × hours assigned to each lesson.)

g — Estimated cost of development of lesson material per student-contact hour over a five-year period, *provided* lessons are used at a maximum rate by 86 students per class.

h — Prog. P – Student worked exclusively in developing Veterinary Public Health instruction.

used by lesson programmers, and trained and assisted lesson programmers in the use of the TUTOR language. The mathematics major spent approximately half time monitoring the PLATO classroom and half time programming lesson material.

The veterinary student programmers developed lessons in conjunction with their classes and in cooperation with their instructors. They were able to approach lessons from a student's point of view, which proved to be an asset in attracting student use. The selection of most of the veterinary student programmers began in the summer before they entered veterinary school. Records of all new veterinary students were reviewed and those with educational, mathematical, or computer background were contacted. Within budget limitations, those desiring part-time employment were offered a job on an hourly basis. After a trial period, usually one semester, they were employed as quarter-time teaching assistants for the school year and full-time in the summer. One of the students had two and one-half years' teaching experience. Another had a B.S. in Electrical Engineering and an M.S. in Biomedical Engineering. All had B.S. or M.S. degrees.

The seven non-veterinary related programmers were selected for their experience in working with PLATO, for their expertise in a related field, or for their ability to proofread lessons for errors in English usage.

The salaries of individuals varied according to their rating, length of employment, and date of employment. In general the cost of an hour of instruction was higher for more highly paid programmers.

Estimated Time for Lesson Development

The estimated time for lesson development is frequently requested by prospective users of the PLATO System. A precise answer cannot be given because of the many factors bearing on the decision; however, Tables II and III provide some information.

Table II lists each programmer employed by the CVM PLATO Project for the four-year period. The amount of time for which the individual was paid was reduced to hours and divided by the number of hours of instruction produced. Several programmers worked more, others less,* than the hours for which they were paid. Even those who maintained a record of their time frequently devoted non-work time to productive thinking or classroom activities which contributed to their program.

Another factor affecting the number of hours required to produce one hour of instruction is the length of time lessons have been in existence. Most of the early lessons have continued being developed and revised. The capacity of the system to receive feedback information from users and its facility for rapid editing provide a unique capability of continuous editing not possible in printed publications. Lessons which have been in existence and undergoing revision for a long time are correspondingly more expensive than newer lessons.

Several employees were responsible for other activities such as classroom monitor on evenings or weekends, or project administration. Two individuals were computer programmers and assisted others in lesson production.

*These individuals were frequently highly productive during the hours they worked.

TABLE II

ESTIMATE OF TIME REQUIRED FOR LESSON DEVELOPMENT
(Four-year Period)

		Estimated Hours Worked	Instructional Hours Produced	Hours to Produce One Instructional Hour
Veterinary Student Lesson Programmers:				
Programmer S		583	9	65
Programmer W		879	15	59
Programmer T		1,844	12	154
Programmer X		908	17	53
Programmer B		2,503	13	193
Programmer M		1,472	18	82
Programmer G		2,567	40	64
Programmer I		2,739	57	48
Programmer F		1,260	13	97
	SUBTOTALS	14,755	194	
	AVERAGE			90
	MEDIAN			65
Non-Veterinary Student Employees Who Programmed Lessons:	Estimated Time Devoted to Lesson Programming			
Programmer E--Senior Programmer	100%	1,380	1	1,380
Programmer C--Project Coordinator-½ time programming	25%	1,896	26	73
Programmer A--½ time classroom monitoring; ½ time programming	50%	1,049	34	31
Programmer D--Computer Programmer and Lesson Programmer Supervisor	100%	2,780	41	68
Programmer Q--½ time classroom monitoring; ½ time programming	50%	493	3	164
Programmer R--Assistant Coordinator	100%	1,907	11	173
Programmer K--English major-proofreading of lessons	100%	1,065	5	213
	SUBTOTALS	10,570	121	
	AVERAGE			300
	MEDIAN			164
	GRAND TOTALS	25,325	315*	
	AVERAGE			182
	MEDIAN			78

*Two additional hours produced by program learner and non-programming typist.

For the four-year period, veterinary student programmers averaged about 90 hours to produce one hour of instruction; however, since the times used by two programmers were extremely high, the median of 65 hours is considered more valid statistically. The average and median for all programmers were 182 and 77.5 respectively. As the project continued, the average number of hours required to produce one instructional hour decreased. The average time for programmers presently employed is 62 hours. Unproductive programmers are no longer employed. Figure 1 shows the average production time of all programmers who have worked with the project.

Programmer Efficiency

The fact that some programmers take more time to produce an hour of instruction than others does not necessarily imply that the individual is less efficient. Lessons vary greatly in their quality and complexity. Programmer involvement varies greatly. Some programmers design and program the lesson almost entirely on their own, while others have lesson designs laid out and then need only do the programming. The use of audiovisuals (slides, audio, and manuals) or graphics requires more time per lesson. Some programmers select topics which assure extensive student use. Although they produce less instructional hours than other programmers, student-contact hours for their lessons are high.

Some other factors influencing programmer efficiency are:

a) Stage of development of the system.

b) Length of employment.

c) Use of audiovisuals. The production testing, revision, etc., required more time on the part of the programmer.

d) Other activities. Some programmers performed other functions, such as classroom monitor in addition to lesson programming.

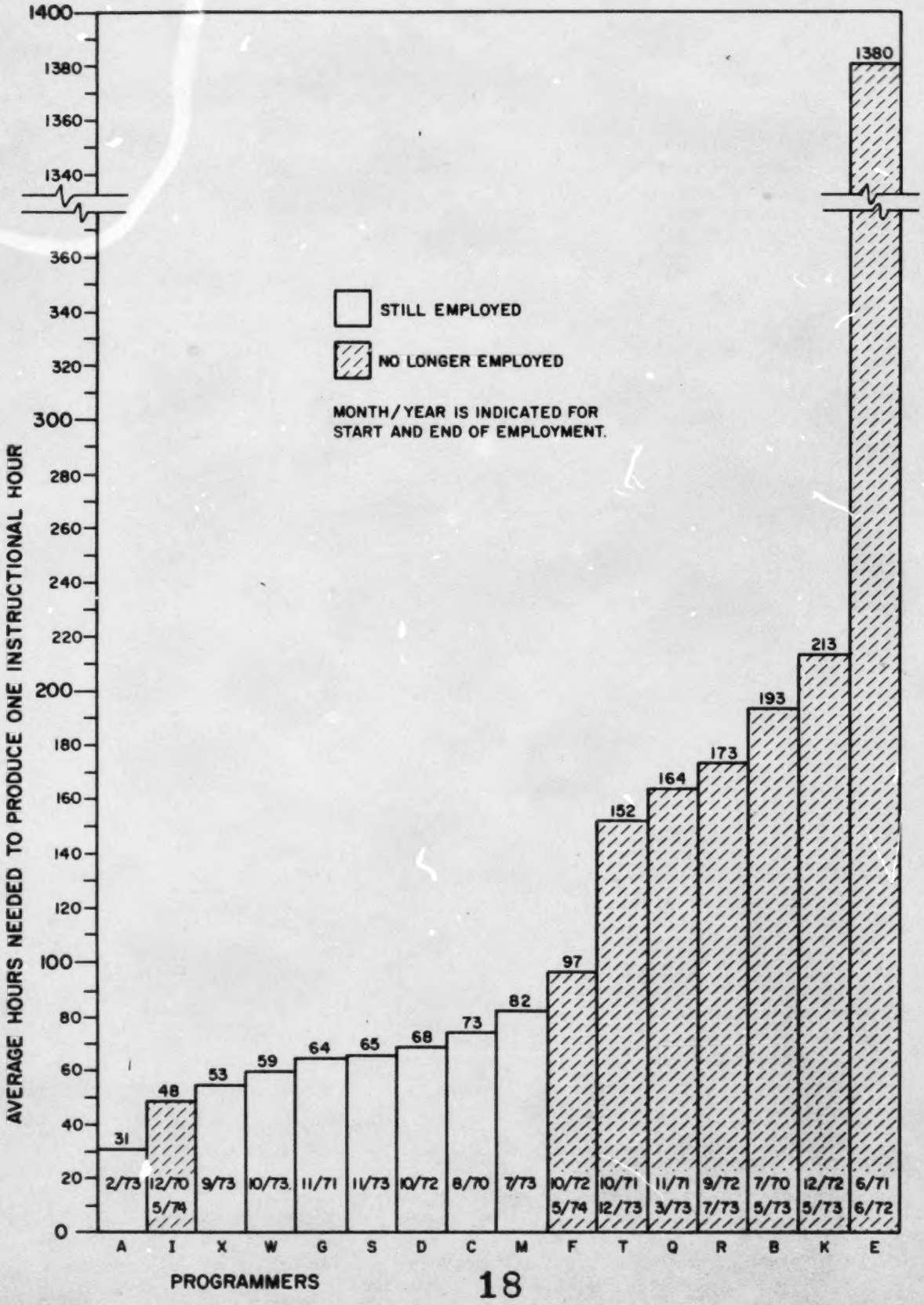

Figure 1. Average Production Time and Period of Employment of Programmers

e) Ability of the programmer. Some were more proficient than others.

f) Application of the programmer. Some put in more time than others, although paid for the same amount of time.

g) Knowledge of subject matter. Programmers with less knowledge about veterinary medicine were less efficient in lesson programming than others.

Approximately 15% of lesson programmers employed were deemed inefficient and their contracts were not renewed. One of these was a total loss with no lessons produced.

Cost of Lesson Programming After Two Years' Experience

Table III indicates the programming cost and time to produce an hour of instruction after the project had been underway for two years. Four programmers were selected who were employed during the period and whose hours of instruction produced were reasonably distinct. Programmers I and G were employed before September 1972. The other two programmers, programmer M and programmer X, were employed after September 1972. Within 15 months programmer X learned to manipulate the system rapidly and approached programmers I and G in efficiency.

Expected Future Cost of the CVM PLATO Project

Several factors indicate that lesson development can be performed more quickly, efficiently, and inexpensively in the future. Lesson development costs should be reduced sharply provided the economy is static. There is an increased ease in programming a lesson; programmers are becoming more expert in lesson programming and lesson design for programming. There is an improved knowledge in recognizing lessons that are suitable for programming. Administration of the project has improved with experience.

TABLE III

SAMPLE COST OF LESSON PROGRAMMING DURING SECOND TWO YEARS OF PROJECT

	Programmer I[a]	Programmer G[b]	Programmer M	Programmer X
Programming time period between 9/72 and 9/74	9/72-5/74 21 mos.	9/72-9/74 24 mos.	6/73-9/74 15 mos.	9/73-9/74 12 mos.
Hours of instruction produced since 9/1/72	34	29	18	17
Amount paid	$5,008.70	$7,601.53	$5,824.58	$3,006.48
Cost per hour of instruction	$ 147.31	$ 262.12	$ 323.59	$ 176.85
Hours worked[c]	1,244	1,776	1,472	908
Time required to produce one hour of instruction	36½	61	82	53½

Average programming cost per hour of instruction $227.47

Average time required to produce one hour of instruction . . . 58¼

[a]Before September 1972 programmer I wrote lessons at the rate of $213.72 and required 63 hours to program one hour of instruction.

[b]Before September 1972 programmer G wrote lessons at the rate of $271.04 and required 72 hours to program one hour of instruction.

[c]Based on time for which paid.

The expected cost of the CVM PLATO Project in the future is dependent on a number of factors; some of these are:

a) Amount of student usage. At present, students use terminals approximately 15% of the time that terminals are available to them. Presently, 21 terminals are available for about 6,000 hours per month and used about 900 hours per month by students. As the number of lesson hours increases, the availability of computer space increases, and more class time is made available for student use; the number of student-contact hours will then increase. As student-contact hours increase, operational costs will remain about the same, and the cost per student will decrease.

b) Amount of continued lesson development. Continued lesson development will require continued employment of lesson programmers and thus increased cost.

c) Number of locations of student terminals requiring monitoring personnel. At present there is one monitored classroom. In 1975-76 a second monitored classroom will be added, increasing costs.

d) Number of operating terminals. A larger number of terminals increases the cost, but improves opportunity for student use.

e) Amount of classroom monitoring desired. Increased monitoring increases the cost.

f) Number of hours classroom will be open. Cost per terminal-contact hour decreases with longer hours of terminal availability.

g) Amount of repair required for terminals and facilities.

h) Employment of personnel to provide released time for instructors. This factor increases costs but improves quality and use of lessons.

i) Amount of statistical evaluation performed.

j) Number of types of audiovisuals needed.

k) Supplementary materials needed.

l) Items included in cost calculations, e.g., office telephone service, computer costs, office supplies, heating, electricity, etc. Some of these costs may be charged to general operating expenses and not to PLATO delivery costs.

Summary

The cost of initial development of PLATO instruction during a four-year period was $483,250. Of this amount, $220,765 were for equipment or renovation. The cost of lesson development for the entire four years averaged about $828.00 per hour of instruction. If 83 students used the lessons in each class at a maximum rate, over a five-year period the cost per student-contact hour averages $1.93. With experience this figure should be reduced substantially.

The median time required for an individual to program an hour of instruction for the entire four years was approximately 77 hours; however, under certain conditions a programmer may require as little as 36½ hours. Programmer efficiency is based on a number of factors such as the quality and complexity of the lessons, experience of the programmer, and his knowledge of the subject matter.

The University of Illinois College of Veterinary Medicine has been *developmental*. The expense of continuing the project at this college or initializing a similar project at another college should be much less as a result of this experience.

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